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INTERIM PRIMARY DRINKING WATER REGULATIONS

Proposed Maximum Contaminant Levels for Radioactivity

ENVIRONMENTAL PROTECTION AGENCY

[40 CFR Part 141]

[FRL 410-3]

INTERIM PRIMARY DRINKING WATER REGULATIONS

Notice of Proposed Maximum Contaminant Levels for Radioactivity

On March 14, 1975, the Environmental Protection Agency published in the FEDERAL REGISTER (40 FR 11990) proposed interim primary drinking water regulations for microbiological and chemical contaminants pursuant to sections 1412, 1445, and 1450 of the Public Health Service Act ("the Act"), as amended by the Safe Drinking Water Act, Pub. L. 93-523. Pursuant to sections 1412, 1445, and 1450 of the Act, EPA today proposes regulations which would include natural and man-made radioactivity among the contaminants regulated by the interim primary drinking water regulations. These proposed regulations also set out the proposed analytical techniques and the monitoring requirements which must be employed in determining compliance with the regulations.

The interim primary drinking water regulations for natural and man-made radioactivity proposed today protect health to the extent feasible, taking costs into consideration, using technology, treatment techniques and other means generally available to the water supplier. Based on past monitoring experience, the Administrator has determined that it is economically and technologically feasible to monitor drinking water at the selected maximum contaminant levels. Thus, for radionuclides, maximum contaminant levels rather than required treatment techniques are being proposed.

In emergencies from unplanned releases such as from nuclear power plants, Federal guidance set forth in the following FEDERAL REGISTER notices will apply: 29 FR 12056 (August 22, 1964), and 30 FR 6953 (May 22, 1965). Emergency actions (by EPA under Section 1431 of the Act and the States under Section 1413 (a)(5)) may be necessary to address the problems associated with unusual exposures.

The Act in Section 1412(b) provides that revised primary drinking water regulations are to be proposed 100 days following the report of the National Academy of Sciences (due 12/16/76) on recommended health-based contaminant levels. Revisions in these regulations may also occur as more is learned about the distribution of radioactivity in water supplies.

Scope of the Problem. Radioactivity in public water systems may be broadly categorized as either naturally occurring or man-made. Of the naturally occurring radionuclides likely to be in public water systems, radium-226 is of primary concern although other terrestrial alpha particle emitters and radium-228 also may be present. Radium is usually not present in significant amounts in surface waters but occurs in ground waters as a result of geological conditions. The full extent of radium contamination in public water systems is unknown. One of the purposes of the monitoring portion of these regulations is to locate contaminated systems so that remedial action may be taken where warranted.

Man-made radioactivity may enter public water systems from a variety of sources. Such contamination is usually confined to systems utilizing surface waters. Past deposition of fallout material from nuclear weapons tests, particularly strontium-90 and tritium, is probably the most important source of contamination. The dose equivalent to individual users of public water systems in some areas of the United States from this pathway is in the range of 1 to 2 millirem (mrem) per year. At present, the dose equivalent from public water systems contaminated by effluents produced in the nuclear fuel cycle is probably only a fraction of that due to fallout materials, though perhaps ranging up to 0.5 mrem per year. The dose equivalent received from effluents released by medical, scientific, and industrial users of radioactive materials that enter public water systems has not been fully quantified. Taken as a whole these users handle much smaller amounts of radioactivity than nuclear power facilities but (with the exception of tritium) their liquid releases and the resultant doses to man may be somewhat comparable.

EPA recognizes that the national use of radionuclides in medicine and industry and the utilization of nuclear power to supply energy needs will unavoidably lead to some radioactivity entering the aquatic environment so that the quality of some surface source waters is likely to decrease slightly in the future. Even though the increase of radioactivity in drinking water will normally be small, the Agency believes that the risk of future contamination warrants vigilance. It is the intent of the proposed monitoring and compliance requirements to provide a mechanism whereby the supplier of water can be cognizant of changes in the level of radioactivity in its water sources, so that appropriate remedial measures can be taken.

Health Risks Associated with Radiation in Drinking Water. The Environmental Protection Agency has adopted a policy which assumes that any dose of ionizing radiation has a potential to produce deleterious effects on human health. The Agency also believes that the extent of such harm can be estimated by extrapolation from the effects on human health that have been observed at higher doses and dose rates than are likely to be encountered from environmental sources of radiation.[1]

For 25 years or more radiation protection limits have been based on the assumption that detrimental effects on health from radiation are proportional to the dose received. Present Federal guidelines state that exposures from man-made radiation should be as low as practicable and should result from activities having a commensurate benefit (Federal Radiation Council, Report No. 2, Background Material for the Development of Radiation Protection Standards, September 1961).

Estimates of the possible health effects from maximum contaminant levels of radioactivity in drinking water have been based on the assumption that there is no harmless dose from ionizing radiation and that the detrimental effects on health produced will be proportional to the dose equivalent delivered to a reference man drinking two liters of water per day.

Methodologies for Selecting Maximum Contaminant Levels for Radioactive Materials. The Agency has examined two rationales for selecting maximum contaminant levels of radioactive materials in drinking water: uniform maximum contaminant levels based on the cost effectiveness of risk reductions; and variable requirements based on an additional limitation on the total dose equivalent to user populations (aggregate dose limit). In general, maximum contaminant levels in drinking water are selected so as to provide uniform protection of individuals at reasonable costs. Where contamination is from uncontrollable sources of radiation, such as geological formations, the cost to reduce the potential health risk can be calculated for various levels of control. It is then possible to select a level of control which balances reduction in health risks with the cost of attaining the desired standards.

As an alternative to considering just the risk to individuals, the Agency also considered an approach based upon both the risk to individuals and the total risk to the population served, i.e., the aggregate dose equivalent received by the population utilizing a given public water system. In this approach the maximum contaminant level is inversely related (within limits) to the size of the exposed population group. An additional maximum contaminant level, which cannot be exceeded regardless of the size of the water system, would be provided as a ceiling on individual exposures. It is possible to set a lower limit and provide more protection for the users of large regional public water systems because the costs for control are shared by a large population and because of the present high quality of the source waters used by large regional systems.

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[1] "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Robert of the Advisory Committee on the Biological Effects of Ionizing Radiation, Division of Medical Sciences, National Academy of Sciences, National Research Council, November 1972, Washington, D.C. 20016.

ORP Policy Statement "Relationship Between Radiation Dose and Effects," March 3, 1975, available from Office of Radiation Programs, Office of Air and Waste Management, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Although the Agency believes there are some valid arguments in favor of an aggregate dose limit, there is an equity consideration involved because an aggregate dose limit would provide for varying degrees of health protection to individuals. For this reason, EPA has rejected an aggregate dose method in these regulations. However, this concept may hold significant potential for future utilization.

Limits for Radium. Near-zero maximum contaminant levels are not practicable for all radioactivity in drinking water because of the degree of variability in current levels of contamination. As a result of geological conditions, radium concentrations in public supply systems range from less than 0.1 pCi per liter to over 60 pCi/1. Since small quantities of radium are present in many foods, a zero level of radium in drinking water would not be very meaningful in terms of controlling the amount of radium in the body. Because the average daily intake of radium in food equals or exceeds 1 pCi, the amount of radium deposited in the skeleton is relatively insensitive to the quantity of radium-226 in drinking water at concentrations less than 0.5 pCi/1.

In contrast to man-made radioactivity for which the environmental impact is controlled by a number of regulatory agencies, the abatement of radium radioactivity in drinking water has received comparatively little regulatory attention. However, in many localities the radium contamination in drinking water is of more concern from a public health standpoint than man-made radioactivity. The Agency has considered both the cancer risk from radium ingestion and the cost of radium abatement in proposing maximum contaminant levels for radium-226 and radium-228.

Total costs to avoid an additional fatal cancer for various reduced levels of radium-226 were calculated on the basis of a sample of 306 community water systems with radium concentrations in excess of 0.5 pCi per liter (Table 1). Calculated costs were minimized by assuming the blending of treated and untreated water where partial treatment is adequate to attain the prescribed standards. In order to estimate the cost of radium removal, it is assumed that the capital and operating costs for an ion exchange system that removes radium will increase the cost of delivered water by 15 cents per 1000 gallons and that each person utilizes 100 gallons per day.

Nationwide monitoring for radium in community water systems has not been carried out or reported systematically. Although the 306 identified systems represent a lower limit on the actual number providing water containing more than 0.5 pCi/1, the Agency has extrapolated that sample to 1100 systems in order to project the national costs shown in Table 1. Also included in Table 1 is an estimate, based on an assumed linear relationship between dose and effects, of the potential number of cancer fatalities averted per year by various control levels.

TABLE 1.—*Comparison of radium control limits*

Control limit pCi per liter	Estimated number of supplies impacted	Annual cost to achieve limit	Estimated total number of lives saved per year
9	240	$1,400,000	.6
8	300	2,400,000	1.1
7	370	3,400,000	1.6
6	450	5,600,000	2.5
5	500	8,800,000	3.7
4	670	14,000,000	5.5
3	800	24,000,000	8.2
2	860	36,000,000	11
1	980	70,000,000	15
0.5	1,100	100,000,000	20

As can be seen in Table 1, a limit of 0.5 pCi per liter would provide the greatest degree of health protection but at an annual cost which is considered incommensurate with the potential risk. The same argument can be made against a limit of 2 pCi per liter. A radium limit of 3 pCi/1 was evaluated because it is the level recommended by the U.S. Public Health Service in 1962. The 1962 USPHS "Standards" applied only to drinking water provided to interstate carriers and were enforceable only for contaminants causing communicable diseases. Thus, this USPHS limit was not an enforceable standard. The 1962 limit was "based upon the judgment that the radioactivity intake from such water supplies when added to that from all other sources is not likely to result in an intake greater than the protection guidance recommended by the Federal Radiation Council, September 13, 1962." Approval of water containing more than 3 pCi/1 of radium was allowed if surveillance of the total intake of radium from all sources indicated the FRC guidance of 20 pCi per day was not exceeded. Some States have incorporated portions of these standards into their public health laws and these limits have served as Federal guides for drinking water quality. It should be noted that under Pub. L. 93–523, States may set more stringent standards if they so desire.

The Agency has also considered for radium-226 and radium-228 a concentration level of 5 pCi per liter with an additional requirement that the aggregate does shall not exceed 3000 organrem per year for systems serving between 50,000 and 500,000 persons. Such a regulation would mean that supply systems serving fewer than 50,000 persons could have a maximum contaminant level of 5 pCi/1 and systems serving more than 500,000 persons a limit of 0.5 pCi/1 with graduated levels for intermediate populations.

In view of the uncertainties about the number of systems impacted and the related cost of control, the Agency is proposing a maximum contaminant level for radium of 5 pCi per liter. Based on the Agency's analysis of the recent NAS Study on radiation effects, the potential risk due to radium drinking water ingestion at 5 pCi/1 is estimated to be between 0.7 and 3 fatal cancers annually per million exposed persons. When additional data on the incidence of radium contamination in public water systems becomes available, the Agency will review the desirability of an alternative maximum contaminant level.

Limits for Man-made Radioactivity. Contamination of drinking water by man-made beta particles and photon radioactivity originates from two sources; ubiquitous activity from deposited fallout, and releases of radioactive materials from medical and industrial applications including effluents from energy generation. Ambient levels from fall-out are decreasing as a result of cessation of most atmospheric testing of nuclear devices. Industrial and medical uses of radioactive materials are rapidly increasing. However, the releases from the latter sources are controlled by a number of regulatory authorities so that the build-up of man-made radioactivity in public water systems should be minimal.

Considering the sum of the deposited fallout radioactivity and additional amounts due to effluents from other sources currently in existence, the total dose equivalent from man-made radioactivity is not likely to result in a total body or organ dose to any individual that exceeds 4 millirem per year. Since present ambient levels of man-made radioactivity are small, EPA does not believe that this standard will result in a need to remove man-made radioactivity from public water systems, nor subject the public to excessive risk.

For man-made photon and beta particle radiation to the total body, the potential risk of fatal cancer from a dose equivalent rate of 4 mrem per year, is about 0.4 to 2 cases per million exposed persons per year with risks from lower dose rates proportionally smaller. Additional health risks of genetic effects and non-fatal cancers are each estimated to be comparable to that for cancer fatality. Partial body irradiation is common for ingested radionuclides since they may, like radium, be largely concentrated in a particular organ system. In such cases, the estimated risk per rem varies depending on the radiosensitivity of the organs at risk. For example, the estimated number of thyroid cancers due to the thyroid gland receiving 4 mrem per year continuously range from about 0.2 to 0.5 per year per million exposed persons (averaged over all age groups). The fatality rate of thyroid cancers varies with age, from nearly zero for children and young adults to about 20 percent for persons well past middle age.

The 4 millirem per year standard for man-made radioactivity was chosen on the basis of avoiding undesirable future contamination of public water supplies as a result of controllable human activities. Given current levels of fallout radioactivity in public water supply systems and their expected future decline, and the degree of control on effluents from the nuclear industry that will be exercised by regulatory authorities, it is not antici-

pated that the maximum contaminant levels for man-made radioactivity will be exceeded except in extraordinary circumstances.

MONITORING REQUIREMENTS

A. *Frequency.* One of the major cost impacts from the proposed regulations is the requirement that the drinking water supplied by an estimated 40,000 community water systems be monitored for radioactivity. The primary purpose of such monitoring is to determine whether these systems are in compliance with the limits prescribed herein.

It should be recognized that some States have already instituted monitoring for the key natural and man-made radionuclide measurements specified in the drinking water regulations. Any analyses made in accordance with the analytical procedures set forth in the regulations, but before the effective date, can be considered when determining compliance.

Natural Radioactivity. The monitoring requirements for natural radioactive contaminants incorporate screening levels below the maximum contaminant level for radium-226 and radium-228. Because the costs of radium-226 and radium-228 analyses are relatively high compared to the cost for the analysis of gross alpha activity, a sequential sampling approach is proposed. A preliminary screening test for gross alpha activity will indicate the presence of potentially significant levels of radium-226. Therefore, a screening level for gross alpha particle activity of 2 pCi/liter has been selected so that even if radium-228, which is not detected by the gross alpha measurement, is present in a concentration equal to that of radium-226, the maximum contaminant level for these two radionuclides will not be exceeded.

Except in the cases outlined below, routine monitoring of naturally occurring radioactivity is required every five years where only surface water is utilized by a community water system or every three years if ground water is utilized. Surface and ground water supply systems are required to monitor only for gross alpha particle activity unless, the average annual gross alpha particle concentration exceeds 2 pCi/l. If this screening level is exceeded, monitoring for the radium-226 must be performed on the same or equivalent sample. If the average annual radium-226 contaminant level exceeds 3 pCi/liter then analysis for radium-228 radioactivity is required also on the same or equivalent sample. The combined radium-226 and radium-228 radioactivity may not exceed 5 pCi/liter. When the maximum contaminant level for gross alpha particle activity of 15 pCi per liter is exceeded, monitoring shall be continued until the annual average concentration based on four quarterly measurements no longer exceeds the prescribed level. If a radium-226 level of 3 pCi/l is exceeded then quarterly monitoring for radium-226 shall be continued until the annual average concentration does not exceed the maximum contaminant level. In some cases, as required by the State, quarterly monitoring for radium-228 is also continued. EPA wishes to encourage continued radium-226 monitoring when the radium-226 concentration is greater than 3 pCi/l but the combined radium-226 and radium-228 concentration level is less than 5 pCi/liter.

Man-Made Radioactivity. Excepted as noted below, mandatory monitoring for man-made radioactivity is limited to gross beta particle activity, strontium-90, and tritium in systems supplying surface water to more than 100,000 persons. Only these larger systems must monitor since they can provide a base-line on the ambient radioactivity concentrations in most areas of the country without imposing major additional fiscal burdens on the States. Initial monitoring of the annual average concentrations must be completed within two years after promulgation of the regulations. Monitoring at four year intervals is required except when maximum contaminant levels are exceeded. In such cases quarterly measurements on composites of three monthly samples are required. EPA encourages monitoring quarterly when the concentration of man-made radioactivity exceeds fifty percent of permitted levels.

In addition to the monitoring for gross beta particle activity, strontium-90 and tritium, cited above, quarterly monitoring for gross beta particle activity, strontium-89, iodine-131, and cesium-134 is required for community water systems utilizing source waters that are also the receiving waters for effluent discharges from nuclear facilities. The State may select the community water systems to be monitored based on the location of the source water intake. It is the Agency's intention that monitoring be confined to the nearest potentially impacted community water system, not all the systems in a given watershed.

The State may allow the substitution of discharge data from nuclear facilities for direct monitoring of man-made radioactivity by the water supplier where the State determines that such data is applicable to a particular community water system.

Public Notification of Non-compliance with Standards. If any of the proposed maximum contaminant levels for natural or man-made radioactivity are exceeded then the operator of a community water system shall give public notice pursuant to the procedures outlined in the existing interim primary drinking water regulations.

B. *Costs—Natural Radioactivity.* For most community water systems the annual monitoring cost for gross alpha activity is estimated at $10 exclusive of sample collection and shipment. The additional costs for individual radionuclides are estimated as follows:

Radium-226 (precipitation method)	$30
Radium-228	40
Combined assay for radium-226 and radium-228	45

Man-Made Radioactivity. The cost of gross beta particle activity, strontium-90, and tritium radioassays is estimated at $60 annually, exclusive of collection and shipment. The additional monitoring costs for community water systems near sources of nuclear effluents is estimated at $570 annually. Estimates of the total national costs for the initial monitoring required by the proposed regulations, and the annual monitoring costs for succeeding years are shown in Table 2.

TABLE 2.—*Estimated national costs for monitoring radioactivity in community water systems* [1]

	Initial survey (dollars)	Annual cost (succeeding years) dollars per year
Public water systems serving more than 100,000 persons	12,000	3,000
Community systems potentially impacted by nuclear facilities	35,000	35,000
Gross alpha particle activity in all community water systems	400,000	130,000
Radium-226 and radium-228	120,000	60,000
Estimated totals	567,000	228,000

[1] Based on an estimated 40,000 community water systems including an estimated 60 systems impacted by nuclear facilities. The estimates of initial cost are high since States are permitted to substitute equivalent data.

Comments and Public Hearing. At a meeting held May 1, 1975, the National Drinking Water Advisory Council made recommendations with respect to these Draft Interim Primary Drinking Water Regulations for Radioactivity. To the extent deemed appropriate, changes have been made in view of these recommendations.

Interested persons may participate in this rulemaking process by submitting written comments in triplicate to the Water Supply Division (WH-450), Environmental Protection Agency, Washington, D.C. 20460, Attention: Comment Clerk, Interim Primary Drinking Water Regulations-Radionuclides.

Comments on all aspects of the proposed regulations are solicited, especially concerning:

1. The number and location of the public water systems impacted by maximum contaminant levels proposed herein;

2. The number and location of water supplies requiring radium analysis at the 2 pCi/liter gross-alpha-particle-activity screening level proposed herein;

3. The estimated preliminary assessments of the costs and technology for radium removal;

4. The validity and appropriateness of an aggregate dose method for setting maximum contaminant levels; and

5. The acceptability of a maximum contaminant level for radium of 5 pCi per liter as opposed to a higher or lower level.

All comments received on or before September 25, 1975, will be considered. If the comments are criticisms of the adequacy of data relied upon by EPA, the comments should identify and, if possible, provide additional data from published literature and the individual should indicate why and how this information should be used.

Copies of the Statement of Basis and Purpose for these Proposed Interim Primary Regulations and other relevant documents are available for inspection at the EPA Freedom of Information Center, Washington, D.C. 20460. A copy of all public comments and transcripts of the public hearings will be available for inspection and copying from the EPA Freedom of Information Center. The EPA Information Regulations (40 CFR Part 2) provide that a reasonable fee may be charged for the copying service.

In addition to considering public comments sent to EPA, the Agency will hold a public hearing at EPA Headquarters, Washington, D.C., on September 10, 1975, 9:30 a.m. to receive comments and statements. Persons who wish to make statements at these sessions are urged to submit written copies of their remarks in triplicate at the time they are presented for inclusion in the record. Persons wishing to attend are also urged to confirm by telephone the exact time and location of the hearing. (Telephone: 202–426–8847)

Dated: August 7, 1975.

RUSSELL E. TRAIN,
Administrator.

It is therefore proposed to supplement 40 CFR Part 141 with the following:

PART 141—NATIONAL INTERIM PRIMARY DRINKING WATER REGULATIONS

1. By revising § 141.2 to include the following:

§ 141.2 Definitions.

* * * * *

(i) "Dose equivalent" means the product of the absorbed dose from ionizing radiation and such factors to account for differences in biological effectiveness due to the type of radiation and its distribution in the body as specified by the International Commission on Radiological Units and Measurements (ICRU).

(j) "Rem" means the unit of dose equivalent from ionizing radiation to the total body or any internal organ or organ system. A millirem (mrem) is 1/1000 of a rem (0.001) rem.

(k) "Picocurie (pCi)" means that quantity of radioactive material producing 2.22 nuclear transformations per minute.

(l) "Gross alpha particle activity" means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample exclusive of the contribution, if any, due to radon and uranium.

(m) "Man-made beta particle and photon emitters" means all radionuclides emitting beta particles and/or photons listed in Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure, NBS Handbook 69, except the daughter products of thorium-232, uranium-235, and uranium-238.

(n) "Gross beta particle activity" means the total radioactivity due to beta particle emission as inferred from measurements on a dry sample exclusive of the contribution, if any, due to potassium-40 and other naturally occurring radionuclides.

2. By adding §§ 141.15, 141.16, 141.25, 141.26 as follows:

§ 141.15 Maximum contaminant levels of radium-226, radium-228, and gross alpha particle radioactivity.

The following are the maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity:

	Picocuries per liter
(1) Combined radium-226 and radium-228	5
(2) Gross alpha particle activity (including radium-226)	15

§ 141.16 Maximum contaminant levels of beta particle and photon radioactivity from man-made radionuclides.

(a) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem.

(b) Compliance with this section may be assumed if there is a gross beta particle activity of less than 50 pCi/l and if the concentration of tritium and strontium-90 are less than those listed in Table A: *Provided that,* If both radionuclides are present the sum of the annual dose equivalents to bone marrow shall not exceed 4 mrem. If the gross beta particle activity exceeds 50 pCi/l, a radiochemical analysis of the sample must be performed to identify the radioactive constituents, and the appropriate total body and organ doses must be calculated. If two or more radionuclides are present, the sum of the annual dose equivalents to the total body or any organ shall not exceed 4 millirems.

(c) Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 millirem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake and using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce.

TABLE A.—*Limiting annual average concentrations assumed to produce a total body or organ dose of 4 mrem/yr*

Radionuclide	Critical organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	2

§ 141.25 Analytical methods for radioactivity.

(a) The methods specified below are to be used to determine compliance with these standards.

(1) Gross Alpha and Beta—Method 302 "Gross Alpha and Beta Radioactivity in Water" *Standard Methods for the Examination of Water and Wastewater 13th Edition,* American Public Health Association, New York, N.Y., 1971.

(2) Total Radium—Method 304 "Radium in Water by Precipitation" *Ibid.*

(3) Radium-226—Method 305 "Radium-226 by Radon in Water" *Ibid.*

(4) Strontium-89, 90—Method 303 "Total Strontium and Strontium-90 in Water" *Ibid.*

(5) Tritium—Method 306 "Tritium in Water" *Ibid.*

(6) Radium-228—"Estimation of the Isotopic Composition of Separated Radium Samples," H. G. Petrow and R. J. Allen, Anal. Chem. 10: 1301 (1961).

(7) Iodine-131—ASTM D–2459 "Gamma Spectrometry of Water." *1973 Annual Book of ASTM Standards, Water and Atmospheric Analysis,* Part 23, American Society for Testing and Materials, Phil., Pa. (1973); or ASTM D–2344–C "Radioactive Iodine in Water." *Ibid.*

Concentrating Iodine-131 Prior to Applying ASTM Tests D–2459 or D–2433–C—"A Method for Determining Iodine-129 in Milk and Water," J. J. Gabay, C. J. Paperiello, S. Goodyear, J. C. Daly and J. M. Matuszek, *Health Physics* 26:89 (1974).

(8) Cesium-134, 137—ASTM D–2459 "Gamma Spectrometry in Water," *1973 Annual Book of ASTM Standards, Water and Atmospheric Analysis,* Part 23, American Society for Testing and Materials, Phila., Pa. (1973).

Concentrating Cesium-134 137 Prior to Applying ASTM Test D–2459—"Evaluation of Ion-Exchange Surveillance Sampler for Analyzing Radioactive Liquid Effluents," H. L. Krieger and G. W. Frishkorn, *Health Physics* 21:591 (1971); or "Rapid Ion Exchange Analysis of Radio-cesium in Milk, Urine, Sea Water and Environmental Samples," A. L. Bone, *Anal. Chem.* 38:89 (1966).

(9) Potassium-40 Calculated from Total Potassium—*EPA Methods for Chemical Analysis of Water and Wastes,* 1971, Page 115: Analytical Quality Control Laboratory, Cincinnati, Ohio.

When the identification and measurement of radionuclides other than those listed above is required, the following references provide information for this purpose.

(i) "Radioassays Procedures for Environmental Samples," National Center for Radiological Health, U.S. Public Health Service Publ No. 999–RH–27 (1967).

(ii) Procedures for Radiochemical Analysis of Nuclear Reactor Aqueous Solutions, H. L. Krieger and S. Gold, EPA–R4–3–014. U.S. Environmental Protection Agency, Cincinnati, Ohio, May 1973.

(iii) HASL Procedure Manual, Edited by John H. Harley. HASL 300, Health and Safety Laboratory, U.S. Atomic Energy Commission, 1973.

(b) For the purpose of monitoring radioactivity concentrations in drinking water, the required sensitivity of the radioanalysis is defined in terms of a detection limit. The detection limit shall be that concentration which can be measured with an accuracy of plus or minus 100 percent at the 95 percent confidence level (1.96 σ, where σ is the standard deviation of the net counting rate of the sample.)

(1) To determine compliance with § 141.15 the detection limit shall not exceed 1 pCi per liter.

(2) To determine compliance with § 141.16 the detection limit shall not exceed the concentrations listed in Table B.

(3) To judge compliance of a public water system with the maximum contaminant levels listed in §§ 141.15 and 141.16, averages of data shall be used and shall be rounded to the same number of significant figures as the maximum contaminant level for the substance in question.

TABLE B

DETECTION LIMITS FOR MAN-MADE BETA PARTICLE AND PHOTON EMITTERS

Radionuclide:	*Detection limit*
Tritium	1,000 pCi/l.
Strontium-89	10.
Strontium-90	1/2.
Iodine-131	1.
Cesium-134	10.
Gross beta	10.
Other radionuclides.	1/10 of the applicable limit.

§ 141.26 Monitoring Frequency for Radioactivity Contaminants.

(a) Monitoring requirements for gross alpha particle activity, radium-226 and radium-228.

(1) To determine compliance with § 141.15, community water supplies shall monitor gross alpha particle radioactivity within two years of the effective date of these regulations. The analysis shall be made on an annual composite of four quarterly samples or four quarterly measurements. When the concentration of gross alpha particle radioactivity exceeds a screening level of 2 pCi per liter, the same or an equivilant sample shall be analyzed for radium-226. If the concentration of radium-226 radioactivity exceeds 3 pCi/1, the same or equivalent sample shall be analyzed for radium-228.

(i) If the average annual maximum contaminant level for gross alpha particle activity or total radium as set forth in § 141.15 is exceeded, the operator of a community water system shall give notice pursuant to § 141.32(a) or (b), and monitoring at quarterly intervals shall be continued until the annual average concentration no longer exceeds the maximum contaminant level. Such monitoring will include radium-228 when required by the State. It is recommended that the monitoring be continued for radium-226 when the radium-226 concentration exceeds 3 pCi/liter even when the total radium does not exceed the maximum contaminant level of 5 pCi/liter.

(2) Suppliers of water who are not required to monitor annually to conform with paragraph (a)(1) of this section shall repeat the analyses on an annual composite of four quarterly samples or four quarterly analyses at least every three years if groundwater is utilized and every five years if only surface water is utilized.

(b) Monitoring requirements for man-made radioactivity.

(1) Within two years of the effective date of these regulations suppliers of water serving more than 100,000 persons shall monitor the average annual radioactivity by measurement of an annual composite of four quarterly samples or four quarterly measurements to determine compliance with § 141.16. If the maximum contaminant level based on an average annual concentration is exceeded then the operator of a community water system shall give public notice pursuant to § 141.32 (a) or (b), and monitoring shall be continued with the analyses of monthly samples or quarterly composites of three monthly samples.

(2) The monitoring required by paragraph (b)(1) of this section shall be repeated at least every four years.

(3) Within two years of the effective date of these regulations, the State shall require quarterly monitoring for iodine-131, cesium-134, and strontium-89 and annual monitoring for tritium and strontium-90 in any community water system utilizing waters contaminated by effluents from nuclear facilities. For iodine-131, monitoring shall be based on at least one sample per quarter. For cesium-134 and strontium-89, monthly samples or composites of three monthly samples shall be used. If the maximum contaminant level based on an average annual concentration is exceeded, then the operator of a community water system shall give public notice pursuant to § 141.32 (a) or (b) and monitoring shall be continued with monthly samples or the analyses of quarterly composites of three monthly samples until compliance is achieved. The State may allow the substitution of discharge data from nuclear facilities for direct monitoring of man-made radioactivity by the supplier of water where the State determines that such data is applicable to a particular community water system.

(c) Exception to Monitoring Requirements.

(1) The monitoring requirements established under this section apply only to community water systems.

(2) Suppliers of water utilizing only ground waters need not monitor for man-made radioactivity: *Provided that*, The State may require additional monitoring of both surface and ground water for man-made radioactivity in special situations.

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3. By revising § 141.31 to include the following:

§ 141.31 Reporting Requirements for Radionuclide Monitoring.

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(b) The supplier of water shall report, within 40 days following a determination of an average annual concentration required to be made by § 141.26, the results of the determination, provided that the supplier of water shall report within 7 days the failure to meet any standards (including failure to comply with monitoring requirements) set forth in §§ 141.15, 141.16, and 141.26. Reports required to be made by this § 141.31(b) shall be communicated to the State.

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